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The tools and techniques of wildlife damage management—changing needs: an introduction

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Abstract

A wide array of tools and techniques is available for managing the growing variety of conflict situations among humans and wildlife. However, changing social dynamics and the emergence of the animal rights movement have led to increasing restriction or elimination of many of the traditional strategies or materials used by wildlife managers, creating a demand for new approaches to wildlife damage management. The challenge to wildlife scientists is to provide data to maintain the broadest array of appropriate, science-based techniques and management options, while fostering the rapid development and application of new technology. Published by Elsevier Science Ltd.

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1. The growing problems of human–wildlife conflict

The continued growth of human populations and their expansion into new areas has increased the interface between humans and wildlife and added new dimensions to the age-old problem of human–wildlife conflict. In addition to the well-known and ongoing problems of wildlife damage to food and fiber crops and the problems caused by commensal rodents and birds in urban areas, new concerns for management of wildlife conflicts have emerged in recent years. These include problems arising from the success of efforts to recover endangered or extirpated species populations, the global expansion and increased recognition of wildlife-borne diseases, the increased recognition of environmental damage caused by vertebrate invasive species, and the growing problems with wildlife in residential areas.

A new recognition and emerging data on the economic and social costs of problem wildlife have provided a perspective more readily understood by managers, legislators, and the public. Conover et al. (1995), based on extrapolations from literature, estimated annual wildlife-related losses in the United States approaching US $3,000,000,000. In addition, they estimated that, in the United States, 75,000 people each year are injured or become ill from wildlife-related incidents and that 415 people die. Pimentel et al. (2000) estimated the economic loss and damage caused by invasive vertebrate species (mammals, bird, reptiles, amphibians, and fish) in the United States at more than US $40,000,000,000.

Social and demographic changes that place more people in direct contact with problems associated with abundant wildlife also have contributed to this recognition. Curnow (2001) summarized a series of social influences on contemporary wildlife management in the United States that provide a backdrop for these changes. These include a declining proportion of the American population directly involved in agricultural production, the transformation of rural areas from agrarian uses by forces such as decentralization and suburban growth, the growth of the American population by 2.6 million people annually, the increasing interaction between people and wildlife, the fragmentation of wildlife habitats, the declining public tolerance of lethal methods of wildlife management (including some traditional tools such as traps), and increasing public interest and participation in resource management decision-making (Curnow, 2001). In addition, as described by Cookson et al. (2001), human migration has increased four-fold in the past decade and the movement of immigrants increases the probabilities of accidental (or intentional) transport of exotic wildlife species and introductions of vector-borne to new areas where they may become established.

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2. New settings, new species

Conflict situations and the kinds of animals involved reach far beyond the well-known problems of animal depredations on crops, livestock, and stored commodities. Increased agricultural productivity is being squeezed from smaller and smaller parcels of land (increasing the unit value of crops or commodities on a particular parcel). Lands once considered marginal or unsuitable for agriculture are being converted to agricultural uses with new technologies to help feed the world's growing human population. At the same time, human settlements are rapidly expanding into areas occupied by wildlife species heretofore unrecognized as "problems". Additional problems result from increasing efforts to close areas to development to protect species or habitats, often without regard to the activity ranges of the animals to be protected or to in-holdings, where land use patterns conflict with those of the surrounding area. Examples include location of refuges that hold abundant wildlife populations near agricultural areas or airports; protected open space areas surrounding residential areas, where wildlife cannot be managed; and forest reserves holding populations of large, charismatic species (such as elephants or large carnivores) with recreational, residential, or village in-holdings within the reserves. Efforts to conserve threatened or endangered species populations or to reintroduce locally extirpated species have created a new and expanding range of problems related to protecting one species from predation or competition by another. These situations present a close parallel to the problems of protecting domestic crops and livestock from wildlife depredations.

The increasingly close associations of humans, their domestic animals, and wildlife in many areas have increased the prevalence of (and human concern for) vector borne diseases. Improvements in surveillance and diagnostic techniques have brought the realization that wildlife diseases that may affect humans or domestic animals are a growing problem requiring attention. Globalization of transportation networks and increased trade, as well as misguided historical efforts attempting to use vertebrate animals or wildlife-borne diseases for biological control, have recently increased the focus on the age-old problem of invasive or alien species. The array of problems related to managing the economic and social costs of human–wildlife conflicts is growing both in reality and public perception, presenting difficult challenges for resource managers, commodity producers, and medical personnel. Scarcely a day passes without the reporting of new or unusual wildlife conflict incidents in the popular press or the emergence of new descriptive data in the technical literature.

3. Existing technology for problem management

In many situations, options or methods for dealing with wildlife damage problems are limited and are often constrained by local, national, or international regulations, laws, or treaties (Fall and Jackson, 1998). Worldwide, there remains a strong contention among those suffering damage that the centuries-old methods of trapping, shooting, and poisoning problem animals are both effective and economically feasible methods by which individuals or governments can alleviate wildlife damage problems, but changing social perceptions and the emergence of the animal rights movement is making this a minority view in many situations.

Biologist and former Alaska governor, Jay Hammond, describing changes in attitudes toward wolf management in Alaska (Hammond, 1998), wrote,

> "Today wolves are far from endangered. There are more wolves here now than in the 1940s when I first arrived. Back then they were subject to intense trapping pressure, poison, and uninhibited aerial hunting. A bounty system was in place and prey populations were much less abundant over most of Alaska. . . . These days few professional biologists deny that under some circumstances a limited control program may be warranted. The dispute comes in determining precisely what those circumstances be. To compound the problem, the least expensive and most surgical procedures to remove wolves are deemed 'unsportsmanlike', requiring bizarre alternatives, such as sterilization, to appease the 'politically correct'."

Those not suffering damage often oppose the use of these traditional lethal approaches to manage situations from which they feel remote or where they are not directly affected, for example, timber or agricultural losses, but promote them in situations where they feel a strong interest for example, invasive species management or endangered species protection (Temple, 1990).

Wildlife damage to crops, property, and commodities is also an issue faced by game management agencies that attempt to coordinate regulated hunting and trapping to minimize damage (Conover, 2001a). Often, the license fees of sportsmen are used to pay damage compensation claims when traditional wildlife population management approaches are constrained. In reality, the options for management tactics in many wildlife damage situations are slowly expanding as a result of research, improvements in practicality, and changes in application procedures; but the issues surrounding choice of methods often remain contentious and politically charged.

Numerous technical reviews of methods and management options for particular species or types of damage problems have been recently published, and more are likely to appear as additional information becomes available. Such reviews are a valuable resource for wildlife managers faced with practical decision-making with limited technical information. For example, Cleary and Dolbeer (1999) have evaluated options for managing wildlife hazards (particularly those associated with birds) on and around airport

facilities; Linz and Hanzel (1997) and Dolbeer (1990) examined options for managing blackbird damage to sunflowers and corn (maize), respectively; and Glahn et al. (2000) assessed the limitations of methods for managing cormorant predation on catfish in aquaculture facilities. Bruggers and Elliot (1989) provided a comprehensive overview of the biology and management of quelea birds in African agriculture. Damage management options have recently been reviewed related to protecting reforestation areas from pocket gophers (Engeman and Witmer, 2000) and from black bears (Witmer et al., 2000a). Nolte and Otto (1996) compiled a catalogue of materials available to forest managers for dealing with the variety of forest damage caused by wildlife species. Recent reviews of methods for managing problems caused by rodents, include material on commensal rodents in urban and industrial situations (Jackson, 1990), prairie dogs in urban and suburban areas (Witmer et al., 2000b), rice damage (Fall, 1990a), and tropical field crops (Fiedler and Fall, 1994), as well as several general books, including Prakash (1988), Buckle and Smith (1994), and Singleton et al. (1999).

Predation on livestock, game animals, and threatened or endangered species often present difficult problems for wildlife managers. Management options for coyote predation on livestock have been reviewed by Fall (1990b), Knowlton et al. (1999), Witmer et al. (1996) and Mason et al. (2001) have examined methods for managing predation on rare species. Management methods and strategies for predation native fauna and other problems caused by introduced brown treesnakes on Guam and other islands have been analyzed by Rodda et al. (1998).

The most comprehensive overview of methods for prevention and control of wildlife damage by numerous species in a variety of environmental situations in North America is the manual by Hyngstrom et al. (1994) which is revised and updated periodically. Considerable current technical information about managing wildlife damage problems is available from the Internet Center for Wildlife Damage Management at http://wildlifedamage.unl.edu/. All of these technical reviews of management options generally conclude that strategies involving use of several methods, lethal and non-lethal, appropriate to the situation and constraints, structured in integrated pest management or IPM programs (Fall and Jackson, 1998), present the best prospects for successful problem resolution.

4. Changes in strategy

There has been a growing public sentiment in many countries, particularly in the past quarter-century, opposing the use and management of wildlife resources. This is reflected in legislation regulating and restricting the methods and strategies available for addressing the problems that arise when humans and wildlife share the same habitats. This sentiment is unlikely to diminish, since the proportion of the human population involved in direct agricultural production and in activities that involve consumptive use of wildlife, continues to shrink. There is also an increased recognition that many wildlife damage problems can be resolved by managing the behavior of individuals or local groups of animals instead of attempting to manage populations on small areas. Fiedler et al. (1982), Bruggers et al. (1983), Mitchell (1986), Sacks et al. (1999), and Knowlton et al. (1999), among others, describe situations in which particular animals or segments of local populations are responsible for crop damage or livestock predation.

We envision a general strategy in which wildlife managers better assess the animal, human, and environmental specifics of an individual problem (perhaps with the assistance of computer databases); identify the appropriate techniques and timing from available arrays, filtered by constraints (decision models); and then put implementation and feedback systems (monitoring) in place to facilitate ongoing problem management (IPM). Although such approaches are now possible for many wildlife damage problems, the specific arrays of techniques that will be available in the future are difficult to predict from where we are now, because of the interactions of research, funding, and regulatory constraints, and new developments in technology and materials.

We have observed that the common development time for chemically-based wildlife damage management techniques, from idea to operational availability (in the rare situations where a straight-line approach has been taken), is about 15 years; but the continual raising of the regulatory bar generally requires continued research to maintain the availability of such materials (Fagerstone et al., 1990). We need to substantially shorten that time period by increasing research and development budgets in relation to society's expectations, by assuring that existing tools remain available despite increasing maintenance costs, and by examining regulatory constraints on both existing tools and those yet to be developed to assure they are realistic and appropriate.

5. The need for new tools and new knowledge

The increased restrictions on traditional tools and the identification of new problems in new environments involving new species of concern have created a pressing need for the development of new technologies for managing human-wildlife conflicts (for example, Kraus et al., 1999; Rodda et al., 1998). Most "new" animal problems, however, are ones that human create and could solve by modifying their own behavior or controlling their own populations. Research needs arise when, for whatever reasons, humans choose not to take these actions or add social or legal complications that make existing technology inappropriate or more difficult to apply.

"Toleration" is still the most widely used strategy for wildlife conflict problems and should probably be the strategy of choice more often than it is. The wildlife

management paradigm of the last century derived from a game management philosophy, characterized as relying on habitat improvement and harvest management, to manipulate wildlife populations. Both managers and researchers have often brought this model to the problems of wildlife damage; clearly, it is inappropriate for many situations. There is a critical need for behavioral information on individual animals of a variety of species in the specific environmental settings where damage or conflicts occur to facilitate the development and use of emerging technologies. We also need, on a continuing basis, more biological information on these species (anatomy, physiology, behavior, biomechanics, individual variation, and geographic variation, etc.) to be better prepared to apply the scientific advances that evolve from research with humans and laboratory or domestic animals. Some potential current applications to be pursued include behavior-modifying drug technology, reproduction control, computer-assisted management, capture technology, barrier technology, surveillance technology, and demand-performance or behavior-contingent technology. A more general strategic need is to bring proactive environmental design and mechanization to wildlife damage management, which has almost always been approached by the use of reactive, labor-intensive methods.

6. High-tech versus low-tech — a challenge

Increasingly, we are looking to developments in biotechnology, electronics, and materials science as sources of methods and approaches to wildlife damage management problems. To be able to develop and utilize (and regulate) such tools, researchers, wildlife managers, and regulatory personnel must have the education and technical training for problem analysis and strategic application of new approaches, as well as the economic resources for their purchase, implementation, and maintenance. Training materials and formal training opportunities in the use of wildlife damage management techniques continue to be limited, although new materials periodically become available (for example, Conover, 2001b). Clearly, economic resources will continue to restrict the application of wildlife damage management approaches that are proffered as widely suitable and methods development must, from its earliest stages, be oriented to context and constraints. Can high-tech approaches be modified for low-tech applications? Posting of a family's children to keep grain-eating birds out of crop fields, still common in many countries, may save the crop, but at the sacrifice of the children's education. Often, few alternatives are available. The development and availability of new tools and techniques for managing human wildlife conflicts will require increased skills among users, increased specialization among wildlife managers, and a greater focus on the economics and ecology of specific problem situations. The challenge is to maintain the broadest array of appropriate techniques and management options while fostering the rapid development and use of improved approaches.

7. New technology — a symposium session

This paper introduces a special issue of *International Biodeterioration & Biodegradation* in which papers derive from a symposium session, "Future Technology for Managing Problems with Vertebrate Pests and Over-abundant Wildlife," organized in conjunction with the 11th Triennial International Symposium of The Biodeterioration Society in Arlington, Virginia. The session brought together participants from several countries to discuss how these problems may be managed in the future and the types of research underway to make effective problem resolution possible. Additional submitted papers from symposium participants and others have been included to address this theme. A previous special issue (Fall and Jackson, 2000) included other papers from the symposium session.

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